ENVIRONMENTAL ASSESSMENT TOOLS AND EFFICIENCY IN HOUSING AND OFFICE REFURBISHMENT

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Most environmental sustainability assessment tools are focused on new construction while refurbishment of buildings presents a different picture. Short term, local environmental effects such as noise or dust are more frequent in a refurbishment process since both occupants and neighbours are affected whereas in new construction only neighbours might be affected. The purpose of this paper is to provide a framework in order to assess strength and weaknesses of environmental assessment tools for housing and office refurbishment projects, taking into account practical aspects, fundamentals of sustainability as well as conflicts between sustainability and efficiency. A review of literatures on sustainability, measurement systems in general and major environmental assessment tools confirms that these tools focus on energy consumption, heat insulation, air quality, light, noise, water efficiency and material consumption in new construction, but rarely in a refurbishment context. Short term, negative effects during a renovation process are not covered by current environmental assessment tools. The conflict between local and global effects of sustainable refurbishment, users' needs, workers' efficiency during the refurbishment process, problems caused by occupants and waste management should be reflected in a framework for indicators to be used in refurbishment projects. Since there are important effects on building users involved in most refurbishment processes, more attention should be paid to the relation between their productivity and both economic and social sustainability.

Keywords: environmental impact, measurement, productivity, refurbishment, sustainability.

INTRODUCTION

In Europe, the building stock is old and therefore the maintenance and refurbishment of the existing buildings are critical issues for sustainable building construction (Haapio and Viitaneiemi 2008). In order to satisfy financial, legislative and social demands, sustainable refurbishment in most cases seems like the best option, especially when the architectural heritage is intended to be preserved. Refurbishment also generates more waste than new construction and the content of this waste is less

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predictable in terms of what it consists of. Therefore the shift from new construction to refurbishment makes it necessary to look at the fundamentals of sustainability.

Sustainability is generally analysed in three categories: environmental, social and economic. However, authors from different perspectives deal with sustainability in different ways. A more traditional and anthropocentric economic view (Toman 1994) suggests that mainly environmental sustainability is based on two dimensions, intergenerational equity and substitutability of social capital. When it comes to the ecologist view, Passmore (1980) touches upon the difference between conservation and preservation. In conservation, aim is to save for future generations where intergenerational equity is pointed out. On the other hand, preservation means that species and wilderness must be kept in their present condition. These fundamental ideas which include the consideration of relations between humans and nature as well are coming mostly from ecologists (Baumgartner and Quaas 2010) and they highlight the issue of dealing with waste coming from refurbishment.

Refurbishment offers different challenges than construction of new buildings and most environmental assessment tools do not consider the unique challenges and conflicts of refurbishment. Short term, negative effects during the refurbishment process are not recognized in these tools. There are also other conflicts remaining such as sustainable refurbishment decreasing the energy costs while perhaps increasing rents and thus affecting social sustainability. BREEAM Refurbishment Domestic Buildings is the most recent (June 2012) and only environmental assessment tool that evaluates the refurbishment projects.

Earlier literature on environmental assessment tools (Crawley and Aho 1999; Cole 1998; Forsberg and Malmborg 2004; Haapio and Viitaniemi 2008; Kajikawa *et al.* 2011) usually compare them with each other through the indicators they have, however there has not been any study that analyses these tools in the refurbishment context. Thus, in this paper the fundamentals of sustainability, challenges and conflicts in sustainable refurbishment and essentials of the existing environmental assessment tools are in focus. Such an approach increases our understanding of these concepts and helps us to synthesize them in the practical applicability of tools for both designers and refurbishment contractors.

In particular, the relation between tools for environmental sustainability should be viewed also in an efficiency perspective that is related primarily to economic sustainability. The conflict between efficiency and economic sustainability should be pointed out since efficiency reflects the short term productivity (productivity during the refurbishment process) while economic sustainability refers to long term consequences. Therefore, the purpose of this paper is to provide a framework in order to assess strengths and weaknesses of environmental assessment tools suitable for housing and office refurbishment projects, taking into account both fundamental conflicts of sustainability and practical aspects.

METHOD

This deductive study is based on a literature review in areas of sustainability, measurement systems in general and earlier analyses of environmental assessment tools. The empirical base of the study is major systems of existing environmental assessment tools for (new) construction and the recent BREEAM Refurbishment Domestic Buildings.

SUSTAINABILITY AND THE CONSERVATIONIST DILEMMA

Dealing with sustainable refurbishment is more complex than sustainability in new construction since the environmental impacts of waste are more visible in refurbishment and requires more attention. Thus a few distinctions should be made between refurbishment and new buildings which requires a look at the ecologist perspective and its fundamentals. The conservationist view is one of these perspectives; Passmore (1980) starts the debate by clarifying the difference between conservation and preservation. He sees conservation as saving for the posterity whereas preservation is saving from destruction. His ideas are mostly based on consideration of posterity. Thus he suggests a differentiation between the terms pollution and exhaustion, where pollution is using the resources wastefully which will influence posterity's ability to civilize or in a worse scenario, survive. Hence the essential conservationist idea is to avoid pollution of air and water even though we have to decrease the present industrial activity.

Intergenerational equity and social capital are two dimensions that may provide a better understanding of the ecologist view. Substitutability between the services provided by natural capital (material resources, waste absorption, cultural values etc.) and services from other forms of social capital (buildings, knowledge, skills etc.) is the main concern of social capital dimension whereas the idea of saving for the sake of our posterity is an issue of intergenerational equity (Toman 1994). In that sense, the conservationist idea is more optimistic in terms of substitutability of social capital since the main concern is to achieve intergenerational equity. On the other hand, in preservation social capital is accepted as non-substitutable and the aim is to keep the species and wilderness as they are even if they are harmful to human beings. Therefore the main concern in preservation is the nature where intergenerational equity is totally disregarded. In that case issues such as resource use and waste management in refurbishment should be highlighted since they are expected to have bad influences on the nature (Passmore 1980).

From an economic viewpoint, Toman (1994) analyses the common views of sustainability in three categories: neoclassical presentism, neoclassical egalitarianism and ecological organicism. Neoclassical presentism is one of the most optimistic views where it is thought that natural resources are remediable through substitution and technical advance. In order to be sure that intergenerational equity is achieved, neoclassical presentism suggests using the present value. Neoclassical egalitarianism carries the same mentality as neoclassical presentism in terms of social capital; however in neoclassical egalitarianism, risks such as a potential shortfall in total saving for future are considered in the present value analysis. The first two categories are obviously based on the assumption that the price system can solve the problems related to sustainability. However there are minor issues remaining that should be considered in the refurbishment context such as that in neoclassical presentism, perfect knowledge is assumed to exist. But one should consider that in reality, knowledge among refurbishment clients is inadequate which explains why a client needs architects and consultants.

The last category, ecological organicism, is totally different from the first two views since it is claimed here that natural resources are limited. Moreover, this view does not only focus on individuals, instead it focuses on ecological systems and humanity as a whole, an approach which is related to the justice view of Baumgartner and Quaas (2010). The basis of ecological organicism is the idea of an ecological system

breakdown due to a chain of activities. In a refurbishment context it is unlikely that resource use might cause ecological system breakdown. However the waste from the refurbishment process might be different and more threatening from a system viewpoint.

SUSTAINABLE REFURBISHMENT

As stated, refurbishment presents different characteristics and challenges than new construction. This is mainly due to the stakeholders (occupants and neighbours) involved in the refurbishment process. Especially when sustainability is the focus in refurbishment, conflicts between the aspects of sustainability, in particular with social sustainability becomes more obvious. Therefore an understanding of these challenges is needed in order to address these issues in environmental assessment tools.

A number of authors have identified advantages associated with refurbishment. In one of the earlier studies, Keeping and Shiers (1996) present the major benefits of sustainable refurbishment as lower energy costs, lower maintenance costs and healthier buildings. Mickaityte *et al.* (2008) provide a longer list of expectations from sustainable refurbishment as energy savings, increase of comfort, healthy working environment assurance, increased building life cycle, economized usage and environmental protection. Yau *et al.* (2008) focus on the owners' perspectives and show that refurbishment increases the price of the properties. It is clear that concerns on energy consumption are considered as one of the main triggers of sustainable refurbishment. Increased energy prices are given as a primary reason that encourages energy saving refurbishment (Papadopoulos *et al.* 2002). Reed and Wilkinson (2005) add legislative reasons to the financial ones for energy saving refurbishment. The role of legislation is easily understood in the light of neoclassical market failures mentioned earlier (Toman 1994). The financial reasons in Reed and Wilkinson's (2005) list do not only concern decreased energy costs. These reasons also include an aspect of efficiency namely increases in staff productivity after refurbishment.

On the other hand refurbishment presents a greater challenge due to stakeholders particularly the ones present in the building during the refurbishment. This can be observed especially in office refurbishment projects where staff productivity is decreased temporarily due to disruptions such as noise and dust during the process. In an Australian study, Bullen (2007) presents a number of challenges that are primarily based on financial issues such as that owners do not see economic benefit in refurbishment, or adaptation problems such as that older buildings may not meet current sustainability standards. When we take a look at energy saving refurbishment, regulatory and financial problems are raised by Papadopoulos *et al.* (2002) as primary obstacles and it is shown that energy saving refurbishment sometimes creates unacceptable economic results.

These studies give a good overview of how different sustainability aspects such as environmental and economic ones conflict in practice. While one of the objectives of refurbishment might be to increase energy saving to reach an environmental and financial goal for the owner, it might lead also to rent increase which could influence the social aspect. Given all these complexities, one might ask how these challenges and conflicts can be managed in practice, especially as supported by environmental assessment tools.

ENVIRONMENTAL ASSESSMENT TOOLS IN PRACTICE

The first two influential studies comparing environmental assessment tools were written by Ding (2008) and Haapio and Viitaniemi (2008). Both studies analyse the existing environmental tools and identify the limitations of these tools, but they use different approaches. Haapio and Viitaniemi (2008) categorise the existing tools based on their classification systems and characteristics. Ding (2008) criticises the existing tools through their characteristics as well but she does not categorise them. Her analysis is based on eight aspects: usability as design guideline, usability for selection optimum project options, financial aspects, recognizing regional variations, complexity (input), evaluation of qualitative and quantitative data, weighting and measurement scales. Haapio and Viitaniemi (2008) formulate a number of limitations which are user based problems, reusability of the building products are not considered, a predicted service life is used, ambiguities in utilization of the results and, economic and social aspects of sustainability are not considered. Both studies assert the importance of environmental assessment tools on decision making in projects although Ding (2007) goes further and suggests a sustainability index for environmental building assessment. Her sustainability index includes four major principles: maximize wealth, maximize utility, minimize resources and minimize impact (on environment). While both studies are useful, they do not consider the specific challenges of different types of construction activities and instead analyse the existing tools in general rather than focusing on individual activities, such as refurbishment.

Because refurbishment is not yet covered by most environmental assessment tools, it may seem premature to develop a framework for assessing the tools themselves. Nevertheless refurbishment shares some problems with demolition and new construction which makes it interesting to see the limitations of existing assessment tools. In their pioneer article, Haapio and Viitaniemi (2008) provide a clear understanding of why these tools are created and how they differ from each other. The differences between the tools are: they assess different types of buildings, they emphasize different phases of life cycle, and they rely on different databases, guidelines or questionnaires.

The criteria behind the categorisation of assessment tools may give an idea about the range of tools and for which purposes they are created. Forsberg and Malmborg (2004) categorize the tools as qualitative and quantitative ones. They mention that qualitative environmental assessment tools such as BREEAM and LEED include some quantitative elements (e.g. energy use) while the rest is based on qualitative criteria. It may also be useful to show that different tools include various indicators to measure different aspects. However there remain some common areas that these tools focus on which are energy consumption, heat insulation, air quality, light, noise, water efficiency and material consumption. Obviously a wide range of environmental assessment tools exists and they show different characteristics depending on their essential principles which directly influence their application in practice.

Why environmental assessment tools?

One of the core issues related to environmental assessment tools is the question of why we need them or what makes them so important that many practitioners and researchers are engaged with them. The answer can help us to understand what is expected from environmental assessment tools, especially in the refurbishment context. In order to address this issue, one should understand the benefits gained from

environmental assessment tools. Environmental assessment tools' primary aim is described by Crawley and Aho (1999) as to help consumers to understand what is environmental and orient them towards buying such products or services. Moreover, in the absence of environmental design guidelines, environmental assessment tools implicitly provide guidance. In his pioneer article, Cole (1998) proposes a number of benefits of environmental assessment tools: they provide a common and verifiable set of criteria and targets, they gather and organize detailed information on the building, they can be used by building owners to identify priorities for future administration measures, they provide building owners a means to communicate to prospective tenants the inherent environmental qualities of the building, and they offer a means of structuring environmental information for new building designs and major renovations (note this!) in a rapidly expanding field of knowledge and provide a reference by which building owners and design teams can formulate effective environmental design strategies. The list he presents covers benefits from several processes such as design and operations and also different perspectives such as those of owners and users.

Problems and limitations of environmental assessment tools

Although environmental assessment tools present limitations in the refurbishment context, there might be other limitations that refurbishment shares with other construction activities. As we have seen, Cole (1998) published one of the earliest articles that analyse the environmental assessment tools and categorized limitations as structural or contextual. The structural limitations are given by him as:

- Ability to offer different levels of assessment
- Ability to acknowledge regionally specific environmental criteria
- Use of different measurement scales for different criteria sets
- Weighting of criteria
- Ability to be used as design tools
- Ability to link with other performance issues
- Ability to evolve as field matures
- Remaining voluntary in their application

Following on this early and extensive list of limitations of environmental assessment tools researchers have developed his approach. Todd and Geissler (1999) focus more on the regional limitations since regional differences such as having land or water as scarce resources influence the criteria. Although they stress the importance of considering regional differences, they conclude that having an international or universal tool is the best option since we live in a global village where gas emissions cannot be limited within the borders of regions.

Furthermore, Todd and Geissler (1999) propose partial flexibility in environmental assessment tools in order to solve the regional/universal dilemma. Hence they suggest that the criteria that have international impacts should be fixed such as the ones related to natural resources while the rest of the tool should give enough flexibility to modify the method for scoring performance on each criterion, as well as the method for weighting the importance of each criterion for a specific region.

Fairly recent articles are in coherence with the earlier ones and refine the argumentation. Soebarto and Williamson (2001) add that most tools do not consider costs while Kajikawa *et al.* (2011) present the use of a mixture of qualitative and quantitative measures as a further challenge. Haapio and Viitaniemi (2008) offer a deeper understanding of the limitations from the users' perspectives and claim that there are ambiguities remaining about the reliability of environmental assessment

tools. These ambiguities are assumed to explain low interest in assessment tools. Haapio and Viitaniemi (2008) also mention that users may promote a particular tool just because it gives better results for a certain type of building. Thus a user survey to see what makes users choose one environmental assessment tool rather than another is suggested by them as important.

Clearly, there are difficulties caused by the wide definition of sustainability. Cole (1998) thought that the aim of existing environmental assessment tools was to improve environmental performance by decreasing resource use and ecological loadings. However the concept of sustainability has expanded beyond environmental considerations and now includes two more aspects, social and economic sustainability. Haapio and Viitaniemi (2008) summarize this as the shift from green buildings to sustainable buildings and claim that transforming environmental assessment tools to sustainable assessment tools is still not on the agenda.

The widened concept of sustainability leads to further complications due to different perspectives and the range of actors involved in refurbishment projects. The perception of building performance differs among occupants and owners/investors as well as other stakeholders. While occupants may perceive building performance as air quality and other phenomena that influence their health and comfort, owners perceive building performance as economic performance (Cole, 1998). Therefore, the question of who will use the environmental assessment tools for which purposes becomes important. Environmental sustainability will be matched against (at least elements of) economic sustainability, which emphasizes efficiency.

PROPOSAL FOR A FRAMEWORK

In Table 1, criteria to assess the environmental assessment tools in different contexts are given under different categories. Within the environmental sustainability, an environmental assessment tool is expected to give enough flexibility to adapt criteria to local, regional and national differences. In that sense, it is clear that local effects are more visible in refurbishment than new construction and green buildings which make this criterion more important. The second criterion of the same category comes from the fundamentals of sustainability. Although refurbishment might not create extra problems in terms of resource use, waste should be highlighted as a greater challenge in refurbishment due to uncertainty and the problems often faced in recycling.

The conflict between efficiency and economic sustainability is more obvious in refurbishment since efficiency reflects short term productivity. Efficiency will most probably be lower in refurbishment due to the problems related to output measurement. As a consequence of the problem, output measurement this criterion may have a greater impact on refurbishment. When it comes to the second economic sustainability criterion, it is possible that the environmental assessment tools require excessive input including money and human resource which is a common problem of different construction types. Usability of environmental assessment tool for future operation and maintenance measures can be given as an example. So if the environmental assessment tool is useful for future operation and maintenance measures, stakeholders may be more willing to put more effort in certification.

When it comes to the social sustainability, greater challenges remain in refurbishment due to the stakeholders involved (both occupants and neighbours). Therefore adaptability to individual user needs may be more significant in refurbishment. A common problem in environmental assessment tools is that they are complicated.

While in new construction this might be a minor issue, in refurbishment occupants and workers might be involved in the whole process and thus need to understand the tool. It is also important that an environmental assessment tool facilitates the communication between stakeholders, especially with the current or prospective tenants. Hence an environmental assessment tool should be easily understood by the stakeholders. When it comes to the third criterion, user behaviour such as energy usage preferences of occupants should be highlighted. In refurbishment, since occupants usually are known, more accurate estimates can be made of user behaviour. However in green buildings and new construction, users are very often anonymous which makes this criterion a challenge.

Table 1. Framework for assessment of environmental assessment tools

Criteria	Green buildings	New construction	Refurbishment
1. Environmental			
1.1 Ability to adapt to local, regional and national effects	+	+	++
1.2 Threats to ecosystems (waste and irreversibility)	(-)	+	++
2. Economic			
2.1 Efficiency: consideration of resource use to obtain a given result	(-)	+	++
2.2 Effort in certification (input)	+	+	+
3. Social			
3.1 Adaptability to individual user needs	(+)	(+)	+
3.2 Ease of understanding for stakeholders (including workers)	(+)	+	++
3.3 Ambiguity (user behaviour)	++	+(+)	+
4. Sustainability in general			
4.1 Both process and product evaluation	(-)	+	+
4.2 Yes/No or graded (reliability)	+	+	+
4.3 Compatibility with national building codes, EU directives, standards	+	+	+

In the first criterion of sustainability in general, it is expected that an environmental assessment tool should be used as design guideline and refurbishment production planning. In detail, an environmental assessment tool should assist in identifying optimum project options which highlights the importance of having both process and

product evaluation as a criterion. In terms of product, providing robust technical solutions is important since environmental assessment tools use predicted service life. Hence if some products have shorter service life, it should be easy to replace them. Due to long term characteristics of green buildings, the end product is the important element to assess, not the process. Therefore this criterion is less important for green buildings than new construction and refurbishment.

The recently published (June 2012) BREEAM Refurbishment Domestic Buildings is the only environmental assessment tool that has been created to evaluate the refurbishment process. Refurbishment activities covered by BREEAM Refurbishment Domestic Buildings are alterations to existing dwellings, extensions, domestic conversions and change of use projects. Compared to earlier versions for new construction, more attention is paid to the energy section with 43 % weighting which agrees with the fact that the main intention behind most sustainable refurbishment applications is energy reduction. Sections such as waste, materials and pollution are given less weight than the earlier versions. Finally it should be pointed out that efficiency is partly included in the tool while thinking of refurbishment site waste and efficient use of resources (BREEAM Refurbishment Domestic Buildings 2012).

CONCLUSIONS

Intergenerational equity and social capital are fundamental ideas of sustainability, at least in an ecologist view. These ideas force us to think of our posterity in different ways, while some authors suggest a more pessimistic scenario whereas others are more hopeful about future. Basically the choice of alternative scenarios influence the way we apply concepts such as sustainable refurbishment.

The conflict between local and global effects of sustainable refurbishment is important. Although new construction creates some negative local environmental effects, the level of disruptions such as noise and dust is more obvious in refurbishment. It is primarily due to the fact that during refurbishment both neighbours and occupants are influenced by the negative effects whereas in new construction, only the neighbours, if any, are affected. Waste is one of the major local problems as well and once again, it must be acknowledged that new construction causes waste as well. However the waste from new construction is often easier to identify and recycle than the waste from refurbishment. It is probably so that the proportion between local and global effects is different in refurbishment.

Another conflict can be pointed out between economic and social aspects of sustainability. However this conflict is probably limited to housing refurbishment. In neoclassical economics, rents are supposed to reflect quality which means that after the refurbishment, rents might increase. So the attempts to decrease the costs associated primarily with energy usage result in an imperfect rental market as increases in rents and violate the social aspect. Once again such a conflict is unlikely to be observed in office refurbishment and new construction.

The link between economic sustainability and efficiency or productivity is complicated. Economic sustainability supports the idea of efficient resource use (materials and labour) where these two resources are used in traditional productivity measurement for renovation contractors. In further research, the negative local effects on staff productivity and the link to other sustainability aspects should be considered. A framework that covers principles for an efficient use of energy, heat, air, light, noise, water and materials is needed to achieve a sustainability/productivity balance.

Moreover, practical conflicts arising from the nature of refurbishment should be taken into account. Users' needs, and problems caused by occupants or the workers' performance are a few examples of these problems. It is also vital to remember that regional differences, a common problem shared by all construction activities, should be considered in environmental assessment tools. Thus these tools should give enough flexibility to some criteria to be modified according to region while the rest of the criteria that have global influences should be fixed. Weighting of these criteria should also be modified by considering the essentials of refurbishment.

In this paper, a framework is provided to assess the environmental assessment tools. Further research should investigate the conflicts deeper through case studies and take efficiency into account. Testing this framework in refurbishment context is important to see if the set of indicators work well in assessing environmental assessment tools in terms of different aspects of sustainability and efficiency.

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